

Effect Of Curing Temperature On The Formation, Compression Strength And Morphology Of Pre-treated Fly Ash Geopolymers

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Structured Abstract

Background: The overwhelming use of Ordinary Portland Cement (OPC) in the construction industry is one of the main sources of CO₂ emissions, and it also leads to the depletion of natural resources. Geopolymer concrete (GPC), which is mainly composed of industrial waste materials, including fly ash, provides a promising sustainable solution. Raw fly ash has a high content of unburned carbon and needs to be heated at high temperatures to achieve geopolymer action. Fly ash is an essential component of GPC, where it consists of silica and alumina. The GPC is manufactured by geopolymerization between fly ash and alkaline activators, which are sodium silicate and sodium hydroxide. This study investigates the effects of heat treatment on fly ash and examines how different curing temperatures influence the functional group, morphological, and compression strength of GPC.

Methods: Fly ash derived from a coal-fired power plant was heat-treated at 600 °C for 1 to 4 hours. The untreated and heat-treated fly ash was further analyzed using CHNS, FTIR, and SEM Analysis. The heat-treated fly ash was utilized to prepare GPC, which was cured at 40°C, 60°C, and 80°C and was characterized by means of FTIR, SEM, and compressive strength analysis.

Results: Elemental analysis (CHNS) identified that 2 hours was the optimal treatment through which carbon content was decreased from 4.25% to 0.27%. Then, for GPC, FTIR analysis showed a higher Si-O-Si and Si-O-Al bond formation at higher temperatures, and SEM showed improved microstructural density with fewer voids and unreacted particles, especially at 80°C. The compressive strength increased significantly with temperature, from 0.0421 MPa (40°C) to 0.241 MPa (80°C), confirming 80°C as the optimal curing condition.

Conclusion: In conclusion, the findings of this study indicated that the optimum heat treatment duration for fly ash has been determined to be 2 hours, and 80°C was determined to be the optimum temperature as it provides the highest compressive strength.

Keywords: geopolymer, fly ash, heat treatment, alkaline activator, temperature

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